NATIONAL BUREAU OF STANDARDS REPORT

10 652

EVALUATION OF LEAD PAINT REMOVAL AND DETOXIFICATION METHODS

Milestone Report (7a)

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards [1] was established by an act of Congress March 3, 1901. Today, in addition to serving as the Nation's central measurement laboratory, the Bureau is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. To this end the Bureau conducts research and provides central national services in four broad program areas. These are: (1) basic measurements and standards, (2) materials measurements and standards, (3) technological measurements and standards, and (4) transfer of technology.

The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Center for Radiation Research, the Center for Computer Sciences and Technology, and the Office for Information Programs.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement; coordinates that system with measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of an Office of Measurement Services and the following technical divisions:

Applied Mathematics—Electricity—Metrology—Mechanics—Heat—Atomic and Molecular Physics—Radio Physics [2]—Radio Engineering [2]—Time and Frequency [2]—Astrophysics [2]—Cryogenics.[2]

THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to improved methods of measurement standards, and data on the properties of well-characterized materials needed by industry, commerce, educational institutions, and Government; develops, produces, and distributes standard reference materials; relates the physical and chemical properties of materials to their behavior and their interaction with their environments; and provides advisory and research services to other Government agencies. The Institute consists of an Office of Standard Reference Materials and the following divisions:

Analytical Chemistry—Polymers—Metallurgy—Inorganic Materials—Physical Chemistry.

THE INSTITUTE FOR APPLIED TECHNOLOGY provides technical services to promote the use of available technology and to facilitate technological innovation in industry and Government; cooperates with public and private organizations in the development of technological standards, and test methodologies; and provides advisory and research services for Federal, state, and local government agencies. The Institute consists of the following technical divisions and offices:

Engineering Standards—Weights and Measures — Invention and Innovation — Vehicle Systems Research—Product Evaluation—Building Research—Instrument Shops—Measurement Engineering—Electronic Technology—Technical Analysis.

THE CENTER FOR RADIATION RESEARCH engages in research, measurement, and application of radiation to the solution of Bureau mission problems and the problems of other agencies and institutions. The Center consists of the following divisions:

Reactor Radiation—Linac Radiation—Nuclear Radiation—Applied Radiation.

THE CENTER FOR COMPUTER SCIENCES AND TECHNOLOGY conducts research and provides technical services designed to aid Government agencies in the selection, acquisition, and effective use of automatic data processing equipment; and serves as the principal focus for the development of Federal standards for automatic data processing equipment, techniques, and computer languages. The Center consists of the following offices and divisions:

Information Processing Standards—Computer Information — Computer Services — Systems Development—Information Processing Technology.

THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS and other agencies of the Federal government; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System, and provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world. The Office consists of the following organizational units:

Office of Standard Reference Data—Clearinghouse for Federal Scientific and Technical Information [3]—Office of Technical Information and Publications—Library—Office of Public Information—Office of International Relations.

---

[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
4218388	December 7, 1971	10 652

EVALUATION OF LEAD PAINT REMOVAL AND DETOXIFICATION METHODS

Milestone Report (7a)

by
Elizabeth J. Clark
McClure Godette
Marilyn A. McPherson
Leopold F. Skoda
David Waksman
Lead Paint Poisoning Project
Building Research Division
Institute for Applied Technology
National Bureau of Standards
Washington, D.C. 20234

Sponsored by

Department of Housing and Urban Development

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

ACKNOWLEDGEMENT

The authors would like to thank Mr. David E. Brackett of the Gypsum Association and Mr. Roger H. Higgons of the National Paint, Varnish and Lacquer Association for their many helpful comments and kindly advice.

ABSTRACT

Currently used lead paint hazard elimination techniques have been analyzed in terms of the attributes that can be associated with those methods. The attributes are concerned with hazard inaccessibility, implementation considerations, and in use performance properties. Cost implications can be associated with each of the factors involved in implementation.

TABLE OF CONTENTS

FIGURES

TABLES

EVALUATION OF LEAD PAINT REMOVAL AND DETOXIFICATION METHODS

MILESTONE REPORT (7a)

1. INTRODUCTION

Many factors should be considered in the selection of lead paint hazard elimination methods. In general, each dwelling unit should be treated as a separate entity due to variations in architectural configuration, the structural condition of the unit and the location of the hazard. Certain detoxification techniques are not readily applicable if a building has reached a certain stage of deterioration, or if the leaded material has been used to coat a complex surface, i.e., if there is poor plaster integrity or if complex carvings or radiators coated with leaded paint are present.

Many attributes can be directly associated with each of the potential detoxification methods. In addition to the primary attribute of hazard inaccessibility, which is required of every deleading solution, there are secondary properties that can be related to either work involved in implementation of the deleading process, or to characteristics that reflect the in-use performance of the residence after it has been detoxified. Cost considerations are associated with all of the implementation attributes since they have a direct influence on both the work that has to be done and the time required to do it.

Paths that can be followed in eliminating the lead hazard are outlined in Figures I and II Decision Model--Part I and Part II, respectively. This Decision Model serves both as a display of the various methods available for detoxification, and as an index to detailed matrices relating specific deleading techniques to their attributes.

Figures III and IV, presenting Matrix I--Removal Methods and Matrix IV--Cover Up-Unfinished Rigid Material, respectively, were used to index detailed analyses of those factors implicitly involved in currently used deleading techniques.

DECISION MODEL - PART I

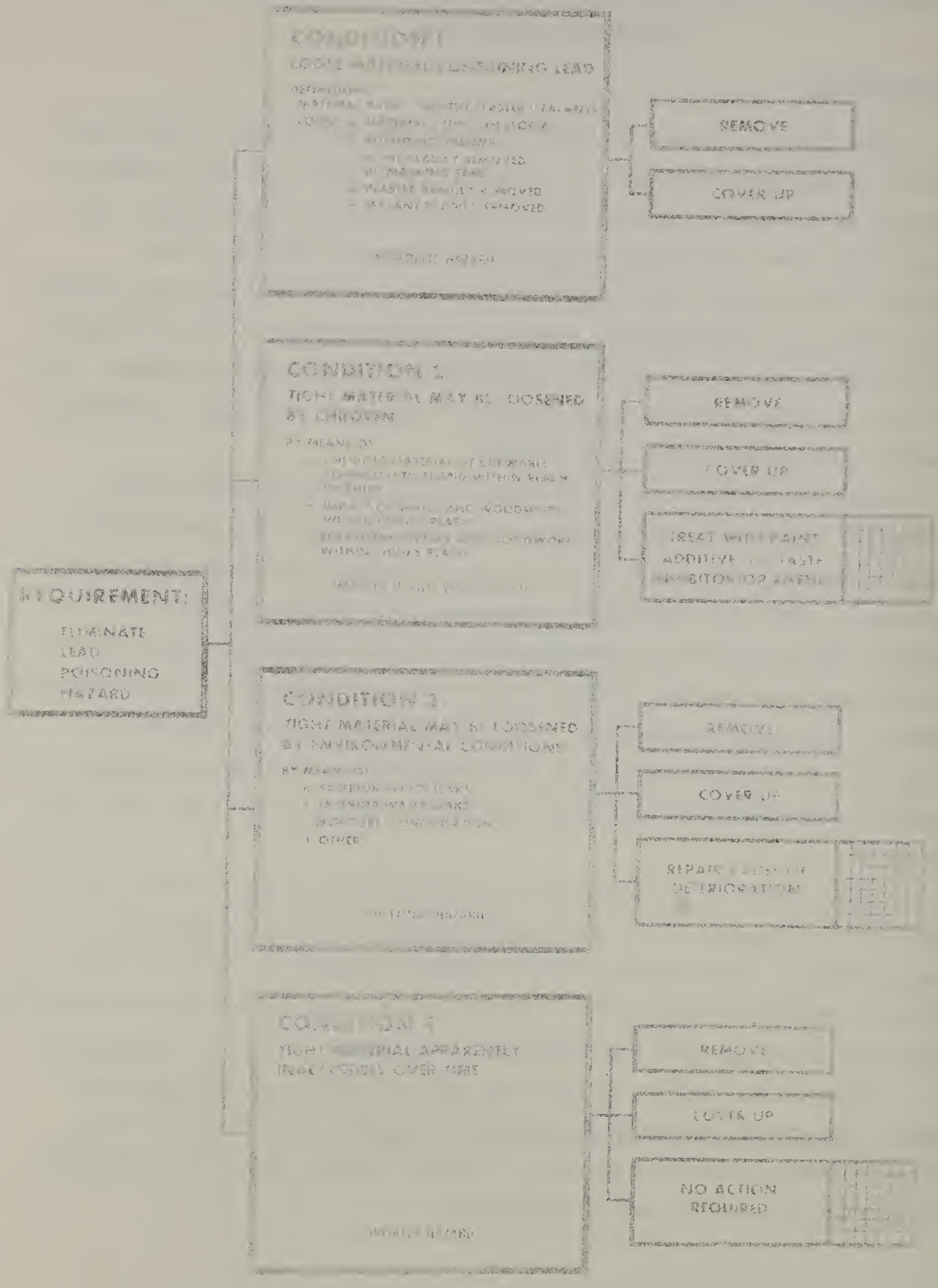


FIGURE 1

DECISION MODEL PART 2

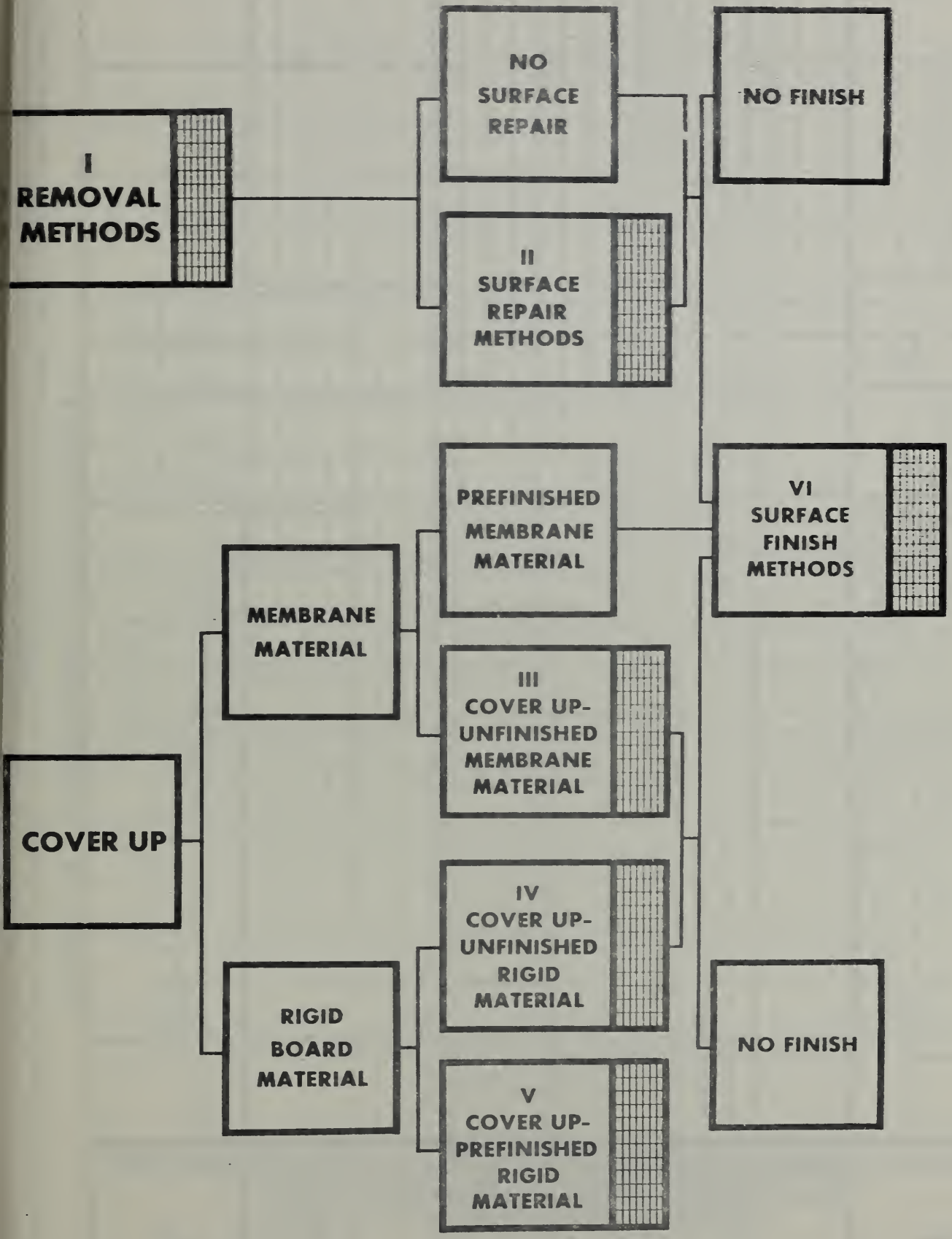


FIGURE II

REMOVAL METHODS

I			1 HAZARD INACCESSIBILITY		SUPPORTIVE ATTRIBUTES									INVOLVEMENT		8 DEGREE OF FINISH	* TIME	IMPLEMENTATION ATTRIBUTES				14 TOTAL COST SUPPORTIVE & IMPLEMENTATION
					2 SPECIAL PRECONDITIONS	3 INSTALLATION HEALTH & SAFETY						4 ANCILLARY WORK	5 WASTE DISPOSAL		6 COMMUNITY	7 USER			10 LABOR	11 MATERIAL	12 EQUIPMENT	13 TOTAL COST	
						a OPEN FLAME	b LEAD FUME	c CHEMICAL SOLVENT	d LEAD DUST	e ELECTRIC HAZARD	f GAS HAZARD		a HAZARDOUS	b NON-HAZARDOUS								
A SAND		WALLS	1																			
		CEILING	2																			
		WOODWORK	3																			
		OTHER	4																			
B SCRAPE	x NO SOFTENING	WALLS	1																			
		CEILING	2																			
		WOODWORK	3																			
		OTHER	4																			
	y HEAT LOOSENING	WALLS	1																			
		CEILING	2																			
		WOODWORK	3																			
		OTHER																				
	z CHEMICAL SOFTENING	WALLS	1																			
		CEILING	2																			
		WOODWORK	3																			
		OTHER	4																			
C OTHER (PLASTER & SEALANT REMOVAL)																						

FIGURE III

COVER UP - UNFINISHED RIGID MATERIAL

IV			HAZARD INACCESSIBILITY	SUPPORTIVE ATTRIBUTES				INVOLVEMENT		DEGREE OF FINISH	TIME	IMPLEMENTATION ATTRIBUTES				TOTAL COST (SUPPORTIVE & IMPLEMENTATION
				SPECIAL PRECONDITIONS (SUPPORT REQUIREMENTS)	INSTALLATION HEALTH & SAFETY	ANCILLARY WORK	WASTE DISPOSAL	COMMUNITY	USER			LABOR	MATERIAL	EQUIPMENT	TOTAL COST	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	GYPSUM BOARD	1	WALLS													
		2	CEILING													
		3	WOOD-WORK													
		4	OTHER													
B	PLYWOOD	1	WALLS													
		2	CEILING													
		3	WOOD-WORK													
		4	OTHER													
C	HARDBOARD	1	WALLS													
		2	CEILING													
		3	WOOD-WORK													
		4	OTHER													
D	METAL	1	WALLS													
		2	CEILING													
		3	WOOD-WORK													
		4	OTHER													
E	OTHER	1	WALLS													
		2	CEILING													
		3	WOOD-WORK													
		4	OTHER													

FIGURE IV

Cost considerations are not included in this report but will be included at a later date.

2. ATTRIBUTES OF DETOXIFICATION METHODS

The primary attribute required of every detoxification method is that it render the hazardous material inaccessible. Success in complying with this requirement is dependent both on the method of hazard removal and the extent to which it is implemented.

The many secondary properties that are inherent parts of specific deleading procedures should be considered very carefully when selecting methods to eliminate the plumbism problem. These characteristics include factors such as the health and safety of both the occupant and deleading workers, the degree of rehabilitation obtained, the potential for recurrence of the problem, etc. A more detailed description of the above attributes follows.

Cost factors can be assigned to many of these considerations since they involve both time and labor.

2.1. Hazard Inaccessibility

Accessibility to residual leaded material is related to both the degree of hazard elimination and the deleading method used. The methods presently in use provide varying degrees of solution. In deciding how high to remove or cover up the lead, one must consider the accessiblity of the remaining hazard and its potential danger to children. The following conditions describe states in which the material may exist and their class of potential hazard.

2.1.1. Condition 1: Loose Material Containing Lead

Definitions:

Material - paint, painted plaster, or sealant

Loose - 1) material lying on the floor
2) blistered or peeling material
3) paint readily removed
4) plaster readily removed
5) sealant readily removed

This material poses an immediately accessible hazard which should be removed.

2.1.2. Condition 2: Tight Material That May Be Loosened By Children.

By means of:

1) chewing - material of a chewable configuration and within reach of the child.
2) impact - on walls and woodwork within reach of a child.
3) scratching - on walls and wood work within reach of a child.

All chewable material represents an immediately accessible hazard and should be removed. Other tight material within the reach of a child represents a hazard of high potential with removal being highly desirable.

The forces that children exert and the heights to which they may reach should be known. Table I, The Average Height and Reach of Children, tabulates, for different ages, the height of a chewable surface and the distance a child can reach standing on the floor. It must be remembered that children often stand on objects such as tables or sofas which increases the height of accessible material.

It has been estimated that a five year old may be able to push and pull with a force greater than 40 pounds [1/], and to bite exerting a force of 100-300 pounds with a bite reach of 1-1 1/2 inches [2/]. Very little is known about the forces a child may exert kicking, pounding, or gouging. Ideally these should be known to set minimum standards for materials used in hazard elimination. However, since a child can pound, hammer, or bang his way through almost anything, it would be very difficult to specify requirements for a child-proof material.

2.1.3. Condition 3: Tight Material That May Be Loosened By Environmental Conditions.

By means of: 1) exterior water leaks
2) interior water leaks

TABLE I

AVERAGE HEIGHT AND REACH OF CHILDREN [1]

	Age Yrs.	Height	Span	Reach (Height + 25% Span)	Chewable Surface (Height)-(6 inches)
	6	45.0	44.0	56.0	39.0
B	5	42.7	41.4	53.1	36.7
O	4	40.2	38.8	49.9	34.2
Y	3	37.3	36.2	46.4	31.3
S	2	33.9	32.7	42.1	27.9
	1	29.5	28.3	36.6	23.5
G	6	44.6	43.3	55.4	38.6
I	5	42.2	40.7	52.4	36.2
R	4	39.6	38.1	49.1	33.6
L	3	36.7	35.1	45.5	30.7
S	2	33.4	32.1	41.4	27.4
	1	29.0	27.7	35.9	23.0

[1] All values are in inches as converted from The Harriet Lane Handbook - A Manual for Pediatric House Officers/Johns Hopkins Hospital, 5th Edition, Year Book Medical Publishers, Inc., Chicago, Ill., 1969.

3) moisture and/or condensation

4) other means

This material represents a hazard of high potential with removal highly desirable.

2.1.4. Condition 4: Tight Material Apparently Inaccessible Over Time.

This material has a low hazard potential with removal being desirable if funds permit.

2.2. Special Preconditions

Certain conditions are required before many hazard removal techniques can be implemented. For example: if a facing is to be put up with adhesive, all loose material should be removed from the surface to be covered and the surface must be free of moisture, oil, dirt, etc. If rigid boards are to be applied there are certain support requirements for the boards, degree of planarity, support spacings, etc.

2.3. Installation Health and Safety

Many of the available hazard removal techniques have health problems associated with them. For example: removing leaded paints by sanding creates a fine leaded dust, softening leaded paint with an open flame can give rise to lead fumes in addition to presenting a fire hazard, cutting various board materials can give rise to a fine dust that can be injurious, etc.

2.4. Ancillary Work

Certain deleading procedures may require additional work to be done in conjunction with implementation of the technique. For example: putting up wall board may require the relocation of plumbing, electrical and heating fixtures.

2.5. Waste Disposal

Care should be taken to ensure that leaded wastes are disposed of in a manner that will render them inaccessible to children. Other

waste materials should be disposed of in a manner such that they do not present a hazard.

2.6. Community Involvement

Community involvement is the degree to which a method allows the utilization of skills, either available or potential, that can be found in a community. Factors such as health and safety, cost, and/or level of training required will determine the extent to which a method lends itself to community participation.

Since limited funds are available for deleading, and cost savings can be realized by utilization of "self-help" labor, certain advantages can be gained by selecting hazard removal methods that lend themselves to the use of semi-skilled and unskilled labor. A secondary spin-off from using this type of labor is the training given in the course of carrying out a community action program. The skills gained can give the people involved a chance to improve their lot in life.

2.7. User Involvement

User involvement is the amount of inconvenience that the occupant of a dwelling unit is exposed to in the course of detoxification of his residence. Some deleading techniques will require the removal of occupants from a residence, while they are being implemented, because of the hazards involved. Other methods require mere dislocation from a room.

2.8. Degree of Finish

Many detoxification techniques leave the dwelling in a crude unfinished state unless further finish work is done. Other methods provide a finished surface in the course of carrying out the method; i.e., prefinished panels.

2.9. In-Use Performance

In general, consideration of performance properties is only applicable to finished surfaces since individual components, such as gypsum board, were not designed for use without the application of a protective surface coating.

2.9.1. Occupant Health and Safety

Attributes to be considered include:

a. Fire Resistance
b. Toxicity
c. Anthropometric Fit
d. Vermin Resistance
e. Mold Growth Resistance
f. Dirt Collection Resistance

2.9.2. Durability and Stability

Properties to be taken account of include:

a. Structural Integrity
b. Scratch Resistance
c. Impact Resistance
d. Abrasion Resistance
e. Moisture Resistance
f. Vibration Resistance
g. Colorfastness
h. Aging Resistance

2.9.3. Acceptability

Several factors in addition to those which affect health and the structural integrity of a residence, including the following should be considered.

a. Washability of the Surface
b. Maintainability of the Surface
c. Acoustic Properties
d. Color
e. Reflectance
f. Attachment Capability
g. Appearance

3. EVALUATION OF PRESENTLY USED LEAD HAZARD ELIMINATION METHODS

The attributes associated with currently used deleading techniques are analyzed in the following sections.

When considering this multitude of factors, one must be careful not to lose sight of the primary requirement that hazardous material be rendered inaccessible to children. The extent to which a method is used, and its success in making leaded material inaccessible where it is used,will determine the degree of success that will be achieved in meeting this requirement.

3.1. Removal Methods

3.1.1. Preliminary Considerations

Where old paint must be removed from surfaces presenting a lead poisoning hazard, several approaches may be followed. Since each method has its limitations and hazards, the following comments are offered for guidance:

Use of solvents or paint removers

It can be assumed that most liquids of this type are flammable and/or give off harmful vapors when used. Any such hazards should be made known by appropriate warnings on the labels of commercial removers. Most products which do not contain substantial amounts of methylene chloride are in the flammable category, or at least combustible, and contain aromatic hydrocarbons or other solvents which can be harmful if concentrated vapors are inhaled for a prolonged period. The vapors of methylene chloride while less toxic than some other solvents used in removers, are sufficiently irritating to require ample ventilation.

Most cities will not permit use of volatile solvent type removers on interior surfaces of dwellings and apartments, particularly if occupied, if the material is flammable or toxic. Thus, removers are useful mainly for structural components (such as doors, windows and the like) which can be moved outdoors for treatment.

On such surfaces the directions for use of the remover should be followed.

When older types of removers are used, the surfaces must be washed thoroughly with a solvent such as turpentine, after the paint is scraped off ,in order to remove waxy residues left by the remover. If this is not done, poor adhesion of subsequently applied paint can result. The newer type of removers, the "water-wash" type, generally contains methylene chloride as the principal solvent and, does not contain waxy material. Surfaces may be washed clean with water after scraping off the paint; this is an advantage. but surfaces must be allowed to dry thoroughly before repainting. Water-washing tends to raise the grain of wood, and sanding to smooth the dried wood is usually necessary.

Burning

Burning and scraping-off old paint is a traditional method but again, some cities will not permit the use of an open flame for interior work due to the fire hazard. Other cities permit open flame use provided that adequate fire-extinguishing equipment is available. Enclosed high-temperature heat lamps have recently been developed which are claimed to be effective and eliminate the fire hazard. The ease of paint removal by burning depends on several factors, including the age and thickness of the paint film; the type of vehicle present in the old paint; and the degree of pigmentation of the paint film. The older types of paint which used a high amount of linseed oil vehicle, together with most enamels, soften fairly readily under heat, whereas old, highly-pigmented flat paints are more refractory. It is easier to burn paint off from wood surfaces than from plaster or masonry. It is not recommended for wallboard substrates.

Mechanical Removal

Hand-scraping with a putty knife or special paint scraper is effective for removing loose and semi-loose paint, particularly on large areas. Care must be taken to use the tool in such a manner

that the edge of the blade gets under the paint film otherwise it can ride on top and fail to remove semi-loose paint which will then peel after repainting. Rotary power tools are now available which work much faster than hand tools and, when properly used, will not damage the substrate.

Sanding, by hand or power tool, is also effective for smaller areas but produces a great deal more dust than scraping. Where lead paint is being removed, the operator must wear a protective respirator, as should others working in the same area, and such work should be conducted only in vacant dwelling units.

On termination of scraping or sanding, particularly the latter, all scrapings and dust should be collected by sweeping and/or vacuuming, and placed in a tight container for disposal.

Wallpaper Removal

In some cases it may be necessary to remove wallpaper to get at old lead paint beneath it. If the wallpaper has not been painted-over or it is not a water and grease resistant type, no particular problem should be encountered. Use of a conventional wallpaper steamer, with a penetrant in the water, should loosen the paper for stripping, even with several layers present. Mechanical wallpaper removers are also available.

With wallpaper of the water-resistant type, or particularly if it has been painted over, removal is a great deal more difficult. The surface must be scored to facilitate penetration by the wallpaper steamer (scoring is also helpful with ordinary wallpaper which has not been painted over). Scoring may be done with a hand tool, or with a rotary power hand tool, as described under "Mechanical Removal". In some cases steaming may be useless and only mechanical removal will be effective.

3.1.2. Analysis of Removal Methods

Removal Methods - Definitions

Sanding - Removal of leaded paint by sanding using either hand operated or mechanical means of implementation. May be applied to either the entire surface or to selected portions, i.e. woodwork. Can be used to remove small amounts of residual paint present after other removal methods have been implemented.

Scraping - No Softening - Hand scraping using a putty knife or similar instrument. Applicable only to loose paint.

Scraping - Heat Softening - Preliminary softening of paint by means of heat (open flame or high intensity heat lamps) followed by scraping, or a combined heating and scraping operation in the case of electric scrapers. Applicable to tight paint as well as loose paint.

Scraping - Chemical Softening - Preliminary softening of paint by chemical means, followed by subsequent scraping. Applicable to tight paint as well as loose paint.

Hazard Inaccessibility (Walls, Woodwork, and Other)

Intercepts: I.A.(1,3,4)-1, I.B.x.(1,3,4)-1, I.B.y.(1,3,4)-1, I.B.z.(1,3,4)-1

If only loose paint is removed, access to lead paint can be gained by chewing tight paint on chewable surfaces, loosening tight paint within reach by actions of the child, or loosening of tight paint by natural causes, i.e. moisture. Removal of paint from any of these above sources renders only the paint on the source treated inaccessible. Only complete removal of all leaded paint guarantees complete elimination of the hazard. (See Table I, Average Height and Reach of Children)

Removal and replacement of woodwork will attain the same goals as removal of paint from the woodwork.

Other surfaces, such as exposed pipes, radiators and furniture, should be considered in the above manner.

Hazard Inaccessibility (Ceilings)

Intercepts: I.A.2-1, I.B.x.2-1, I.B.y.2-1, I.B.z.2-1

If only loose paint is removed, access to leaded paint may be gained if tight paint is loosened by natural causes. Only complete removal of all leaded material completely eliminates the potential for recurrence of the problem.

Special Preconditions

Intercepts: I.A.(1,2,3,4)-2, I.B.x.(1,2,3,4)-2, I.B.y.(1,2,3,4)-2, I.B.z.(1,2,3,4)-2

Surfaces from which paint will be removed should be capable of being repaired if necessary. (See Matrix III - Surface Repair Methods)

Adequate precautions should be taken to protect occupants and workers from hazards created in the deleading process. (See Installation Health and Safety)

Electrical and other fixtures should be protected from damage by chemicals, heat and dust when applicable. Similar protection should be provided for surfaces that will not be treated.

Installation Health and Safety (Open Flame)

Intercepts: I.B.y.(1,2,3,4)-3.a

Burning or softening paint with an open flame within a dwelling presents a potential fire hazard and may be forbidden by municipal codes. Adequate protection against the potential fire hazard should be provided when this method is used.

It is easier to burn and scrape paint off wood surfaces than from plaster or masonry. This method is not recommended for wallboard substrates or wallpaper.

Installation Health and Safety (Lead Fumes)

Intercepts: I.B.y.(1,2,3,4)-3.b

When high temperatures, from paint softening equipment, are applied to materials containing lead, some of the lead may vaporize and produce lead fumes. If controlled temperature heating devices are used at a temperature below which the lead vaporizes, this problem will not occur.

Installation Health and Safety (Chemical Solvent)

Intercepts: I.B.z.(1,2,3,4)-3.c

Most solvents are toxic and/or flammable. If used, the operator must be protected against fumes and adequate fire protection must be provided.

Chemical solvents may cause dangerous burns. Suitable protective garments, i.e., gloves, should be provided to workers who come in contact with such chemicals.

Due to the combination of volatile chemicals in the solvents, potentially explosive concentrations may build up in work areas. For this reason, chemical solvents may be prohibited by municipal codes.

Installation Health and Safety (Lead Dust)

Intercepts: I.A.(1,2,3,4)-3.d, I.B.x.(1,2,3,4)-3.d

Sanding creates finely divided lead dust. Therefore, people in contact with dust must be protected with effective respirators. Because of this dust hazard, sanding is frequently used only to remove paint remaining after other removal methods have been used.

In general, the finely divided dust encountered with sanding will not be created by scraping. Care should be exercised to avoid inhaling the minimal amount of dust that is generated by scraping.

Installation Health and Safety (Electrical Hazard)

Intercepts: I.A.(1,2,3,4)-3.e, I.B.x.(1,2,3,4)-3.e, I.B.y.(1,2,3,4)-3.e
I.B.z.(1,2,3,4)-3.e

Electrical outlets should be covered to protect them from dust generated by a removal method.

Equipment used for paint removal should not overload the electrical circuitry present in the residence, or a fire may result.

Since both heat and chemicals can attack the insulation on electrical wiring,care should be exercised to avoid such damage.

Installation Health and Safety (Gas Hazard)

Intercepts: I.B.y.(1,2,3,4)-3.f

Care should be taken when using heat to soften paint on supply lines for gas operated fixtures, and normal operating precautions should be taken when using gas operated heat softening equipment.

Ancillary Work

Intercepts: I.A.(3,4)-4

It may be desirable to remove items such as window sills, baseboards, doors, windows, etc., to facilitate the removal of paint.

Waste Disposal (Hazardous)

Intercepts: I.A.(1,2,3,4)-5.a, I.B.x.(1,2,3,4)-5.a, I.B.y.(1,2,3,4)-5.a
I.B.z.(1,2,3,4)-5.a

The leaded material generated in the removal process is quite hazardous. Care should be exercised to collect and package the leaded material to render it inaccessible and it should be disposed of in a manner that keeps it in an inaccessible state.

Hazardous waste should not be disposed of in a manner which could put it into the air, i.e., open burning without provision for collection of the leaded ash.

In addition, hazardous waste should not be disposed of in a manner that will permit leaded materials to leach into water systems, since this water may be used for human consumption.

Removal and disposal should be in accordance with applicable local ordinances.

Waste Disposal (Non-hazardous)

Intercepts: I.A.(1,2,3,4)-5.b, I.B.x.(1,2,3,4)-5.b, I.B.y.(1,2,3,4)-5.b
I.B.z.(1,2,3,4)-5.b

Non-hazardous waste should be removed immediately from those areas accessible to people. Since such wastes can provide breeding grounds for vermin, they,therefore,present a health hazard. In addition, people, especially children, can injure themselves by coming into physical contact with the waste material.

Removal and disposal should be in accordance with applicable local ordinances.

Involvement (Community)

Intercepts: I.A.(1,2,3,4)-6, I.B.x.(1,2,3,4)-6, I.B.y.(1,2,3,4)-6, I.B.z.(1,2,3,4)-6

Utilization of a lead detoxification procedure that permits community involvement is very desirable. In addition to potential cost savings that can be realized by using "self-help" labor, valuable skills can be gained by members of the community.

Sanding is a feasible method in terms of community involvement since minimal skills and equipment are required. Although there would be some hazard from lead dust, this could be overcome by the use of protective equipment, such as respirators.

Virtually no training is required for the worker to scrape paint if no softening is required and the only tools used would be a scraper or putty knife. Since only a minimal hazard from lead dust is present, this method offers a maximum potential for community involvement.

Scraping, in combination with heat softening, requires a certain degree of skill. When an open flame is used, in addition to a potential fire hazard problem,there is also a danger from lead fumes. Only trained workers should be allowed to use this method. Other heat softening techniques such as those utilizing electric scrapers and high intensity lamps lend themselves more readily to community participation since the aforementioned hazards are minimized.

Scraping, in combination with chemical softening, does not lend itself immediately to community based labor, since virtually all softening chemicals are either toxic, flammable, or a combination of the two. Safe handling of the above chemicals would require a relatively high level of experience.

Involvement (User)

Intercepts: I.A.(1,2,3,4)-7, I.B.x.(1,2,3,4)-7, I.B.y.(1,2,3,4)-7, I.B.z.(1,2,3,4)-7

Occupants should be removed from the dwelling when sanding, or softening with heat or chemicals due to inherent hazards (see Installation Health and Safety for pertinent techniques).

When scraping is used, occupants should be kept away from the immediate area in which work is being done until the work is completed and the area is cleaned up.

Degree of Finish

Intercepts: I.A.(1,2,3,4)-8, I.B.x.(1,2,3,4)-8, I.B.y.(1,2,3,4)-8, I.B.z.(1,2,3,4)-8

In general, the surfaces after paint removal are crude, easily dirtied, difficult to clean and maintain, and susceptible to attack by moisture. Patching may be desirable if the surfaces are in poor condition and a protective surface finish should be applied. Pertinent surface repair methods and surface finish methods will be considered in a subsequent report.

3.2. Analysis of Cover Up-Unfinished Rigid Materials

Hazard Inaccessibility (Walls)

Intercepts: IV.(A,B,C,D).1-1

a. Partial cover-up to heights of 4 feet, 5 feet, 8 feet.

Hazardous material is inaccessible only where it has been covered with a suitable material. Where the leaded material is left exposed, no matter how well adhered the leaded paints are above the covered portion of the wall, the potential of accessibility by peeling, flaking, or activities of the child is ever present. Partial coverage of walls is successful only if it extends beyond the maximum reach potential of the child. A child 45 inches tall (average 6 years old) standing on a 50 inch high bunk bed can reach over 8 feet. The 50-inch bunk bed would probably offer the greatest height access to the hazard. Tables, chairs, sofas, high chairs, base cabinets would all offer access over 4 feet. (See Table I, Average Height and Reach of Children)

b. Complete cover-up from floor to ceiling.

Hazard accessibility eliminated under normal usage of dwelling unit.

c. Partial or complete cover-up; in use performance.

The hazard can be eliminated where the covered areas are subjected to normal usage conditions. When toys, tools, furniture, or other mechanical means are used to destroy the covering material then the hazard potential is again present. Resistance to punching through the material is dependent on the impact resistance which is a function of material thickness. Thus, 1/4-inch thick material is, most likely, more susceptible to damage than 3/8-inch or 1/2-inch. The forces that can be generated by children in the age group under consideration should be evaluated. This does not imply

that only the children will destroy the covering material; it can also be destroyed by others.

Conclusion: As long as leaded paints exist in living units the hazard of poisoning is potential. Cover-up methods reduce the hazard potential in direct proportion to the strength and durability of the materials used. The cover-up materials provide a barrier only in those areas where they are applied.

Hazard Inaccessibility (Ceilings)

Intercepts: IV.(A,B,C,D).2-1

Under normal usage conditions, cover-up methods for ceilings, by unfinished rigid materials, would provide the maximum possible inaccessibility of hazardous materials. Since the leaded material is still present, there is a slight potential for recurrence of the problem.

Boards or tiles may be attached directly to the ceiling or ceiling panel suspension systems may be used. Panels composed of vegetable fibers, mineral wool, glass fibers, metal, plastic, plywood, hardboard or similar materials are available for use in ceiling suspension systems. Most of these materials are available in either the finished or the unfinished state. The problem with most panel ceiling suspension systems is that the panels are easily removable and consequently the hazard is more accessible than in those systems where rigid materials are fastened directly to the ceiling.

Ceiling cover-up by other than unfinished rigid materials will be covered by Matrix III, Unfinished Membrane Materials, i.e., plaster, cementitious material and other.

Hazard Inaccessibility (Woodwork)

Intercepts: IV.(A,B,C,D).3-1

When it is possible to use the existing wood trim, cover-up methods of woodwork using plywood, hardboard, and gypsum board would include window and door trim, baseboards, wainscoting, and in limited cases,

stairway balustrades. Window sills and window sashes cannot be covered by any of these materials. Although plywood and hardboard can be used to cover doors and cabinetry (excluding leading edges), gypsum board is not applicable for these purposes.

Metal is not a very suitable covering material for woodwork and is only practical for use on doors.

Maximum hazard inaccessibility would be provided by metal, hardboard, gypsum board, and plywood where they can be used. This assumes normal usage by the occupants and neglects malicious destruction that would allow the hazard to become accessible.

Cover-up of woodwork including window sills and sashes could be accomplished by using other materials that are applied in the wet state and become rigid. These possibilities will be described in Matrix III, Unfinished Membrane Materials (i.e., plaster, cementitious meterial, and other non toxic materials).

Special Preconditions (Walls)

Intercepts IV.(A,B,C,D)1-2

a. Gypsum board, plywood and hardboard.

Support requirements for application of unfinished rigid materials are governed by local code requirements or the engineering judgement of the building department officials housing jurisdiction. Three solutions are used; direct attachment, furred attachment, and re-framing attachments. In all three cases the materials to be attached are either mechanically fastened or applied with a combination of adhesives and mechanical fasteners.

The preconditions for direct attachment to existing wall surfaces are that they can not be buckled, bulged or contain large voids. In these cases, mechanical fastening can be used. A further precondition for the walls when the combination of adhesives and mechanical fasteners are to be used is that they be free of loose plaster or paint and that the surface be adequate for the use of adhesives.

When these conditions are not met but the structural components are sound, then furring can be used. Furring can be used in combination with existing baseboard, window, and door trim if they are sound, adequately attached and of the same nominal thickness. When the existing trim does not meet these conditions, then the trim must be removed and the entire wall surface furred. The surfacing material can then be applied to the furring by the two techniques described above.

When the existing structural components (wall or ceiling assembly) are not structurally sound enough to permit the use of furring, then re-framing is necessary. This method supplies a structural framework for attachment of finish materials but the existing exterior walls, floor joists and ceiling joists must be structurally sound enough to permit the attachment of the new structural framework. The surfacing material can then be attached to the reframed walls by either of the two prescribed methods.

When any combination of the exterior walls, floor joists, or ceiling joists are judged to be inadequate, then those components must be replaced (in the case of floor or ceiling joists) or the structure must be condemned.

b. Metal

Support requirements for application of unfinished rigid materials are governed by local code requirements or the engineering judgement of the building department officials. Recommended support systems applicable to the type of metal panel selected should be installed.

In general, since support systems will be fastened to floor and ceiling joists, those joists must have sufficient structural integrity to permit attachment of the support framework.

When any combination of the exterior walls, floor joists, or ceiling are judged to be inadequate, then those components must be replaced (in the case of floor or ceiling joists) or the structure must be condemned.

Special Preconditions (Ceilings)

Intercepts: IV.(A,B,C,D). 2-2

Support requirements for ceiling installations are similar to the conditions described for wall installations. The three solutions used are: direct attachment, furred attachment, and suspended ceiling systems.

The preconditions for direct attachment of gypsum board, plywood, or hardboard are that the existing ceiling surface not be buckled, bulged or contain large voids when mechanical fastening is to be used. When a combination of adhesives and mechanical fasteners is to be used, the ceiling surface must be free of loose plaster and paint and the surface must be adequate for the use of adhesives.

When engineering judgement concludes that the surface is unsuitable for direct attachment, then a furring system for attachment or a suspended system must be used. The precondition for furred or suspended ceiling attachment is that the ceiling conditions must be structurally adequate for attachment of the system.

With metal panels the suspended ceiling conditions must be met as there are no direct attachment ceiling panels available.

Special Preconditions (Woodwork)

Intercepts: IV.(A,B,C,D). 3-2

a. Gypsum board, plywood, and hardboard

The support requirements for covering woodwork with gypsum board, plywood or hardboard are that the woodwork to be covered must be firmly attached to the surface in question and the covering material must be able to perform its intended purpose.

In the case of gypsum board only, window and door trim, baseboards, wainscoting and balustrades would be covered as outlined in IV.A.1-2.

Plywood and hardboard can be used to cover woodwork and also could be used to cover doors and cabinetry. When doors and cabinetry are to be covered with plywood or hardboard then they must be able to perform their orignial function after application. Engineering judgement must be employed to determine if this is the case.

b. Metal

Covering-up of woodwork with metal would be a custom installation for each situation encountered. The practical use of metal would be for covering up of doors. If metal is used, then the supportive requirements would be the same as for the gypsum, plywood, and hardboard, i.e. , those elements to be covered must be capable of performing their original function after covering.

Installation Health and Safety

Intercepts: IV.(A,B,C,D).(1,2,3,4)-3

Cutting sheet materials to size in closed, unventilated areas presents a health hazard to both workers and occupants since fine dust is generated in the process. Work should either be done outside the dwelling unit,or the occupants should be removed from the work area. Adequate air flow should be maintained in the cutting area to remove dust. Ideally, dust bags should be used with power tools. Respirators and safety glasses should be worn. Accumulation of dust should be avoided since this dust may be hazardous.

Ancillary Work

Intercepts: IV.(A,B,C,D).(1,2,4)-4

Ancillary work connected with cover-up methods using unfinished rigid materials will involve electrical, plumbing and heat distribution systems. The basic assumption to be made is that the distribution

systems are performing their intended function satisfactorily at the time when hazard elimination techniques are initiated. If the systems are not performing satisfactorily, then a code violation exists that must be rectified; it is not a part of hazard elimination.

The basic problems encountered would be dependent on what material is used and what method of attachment is used. When direct attachment or furred attachment procedures are used, the relocation of electrical, plumbing and heating fixtures is dependent on the total added thickness to the walls and ceilings which is a result of the hazard elimination method used. When reframing techniques are used, complete renovation of the distribution systems might be necessary.

Ancillary Work (Electrical)

Local codes will outline acceptable procedures for resetting outlets, switches and distribution boxes. When within wall wiring is used, then the outlet boxes may be extended with appropriate adapters or deep boxes may have to be used. Both of these adaptations are dependent on the amount of available wire within the existing outlet boxes. If there is a sufficient amount of wire available, the problems are minimal. If there is an insufficient length of wire available, then junction boxes must be used to extend new wire to the relocated outlets and switches.

When a surface mounted electrical distribution system is present then the entire system must be relocated, as would be the case when reframing techniques are used as the hazard elimination method.

Ancillary Work (Plumbing)

Plumbing problems will occur primarily in bathrooms and kitchens. If at all possible, a hazard elimination method that does not require relocating plumbing fixtures should be used. Sinks and water closets are most generally attached to existing walls; in many cases, fixture movement problems can be eliminated by either framing around the fixtures or using thin covering materials that fit between the fixtures and the wall. If it is necessary to move a sink, then the

plumbing work simply requires the use of longer lengths of pipes to the supply and waste drain lines. Water closet relocations are much more difficult, in that the main drain connection establishes the location of the unit. Any relocation would necessarily require moving the waste drain line, which would require tearing up the floor of the bathroom. Wall areas around bathtubs can be covered with rigid materials without relocating fixtures if the covering system is no greater than 1/2 inch thick. Shower fixtures and in-wall valves and faucets can be extended with adapter fittings up to 1/2 inch in most cases without removal and relocation.

The problem of deteriorated plumbing systems is ever present and when old systems are disturbed, failures can be expected to occur which would lead to costly repairs .

Ancillary Work (Heating Systems)

The possible types of heating systems that may be encountered are fuel burning space heaters, central distribution, and electrical.

The fuel burning space heaters would include coal stoves, oil stoves, and gas stoves. The oil and gas stoves could either be convection heaters or fan driven units. These units (except coal stoves) can either be free standing, suspended, or built-in wall units. Of the fuel burning systems, only the suspended heaters and built-in wall units must be dealt with when rigid cover-up methods are used. Suspended heater systems would only interfere with application techniques and may have to be removed during installation but no alteration need be made except possibly to the suspension hangers. Built-in heater units would have to be moved or the trim reset to conform to the new line of the wall covering system used. Relocation would require the provision of adequate framing to structurally support the new location, as well as extension of the piping and exhaust systems.

Central distribution systems can use hot water, steam, or forced hot air. The heat distribution outlets for the hot water and steam will either be free standing radiators or baseboard type radiators.

The forced hot air systems will be wall mounted registers or floor mounted registers. In the case of hot water or steam radiators, the relocation can be accomplished with a minimum amount of plumbing, which would consist of the addition of longer lengths of pipe. In the baseboard system, it may be necessary to relocate the units to conform to the added thickness of the hazard elimination material used. This would require additional lengths of pipe and consideration should be given to structural support and attachment. The forced hot air systems would only require short metal extensions to existing duct work to conform to the new wall system.

The electrical heating systems can be free standing or wall mounted units. The free standing units do not require any relocation considerations, but the wall mounted heaters would have to be relocated and properly supported structurally to conform to the new wall system. Extension of electrical connections may be required which would conform to extension procedures described under electrical ancillary work.

When working with, or around any heating or electrical devices, extreme care should be exercised in order not to create a fire hazard, i.e., non combustible materials should be used.

Waste Disposal

Intercepts: IV.(A,B,C,D).(1,2,3,4)-5

a. Hazardous

The leaded material generated in the removal process is quite hazardous. Care should be exercised to collect and package the leaded material to render it inaccessible and it should be disposed of in a manner to keep it in an inaccessible state.

Hazardous waste should not be disposed of in a manner which could put it into the air, i.e., open burning without provision for collection of the leaded ash.

In addition, hazardous waste should not be disposed of in a manner that will permit leaded materials to leach into water systems, since this water may be used for human consumption.

Removal and disposal should be in accordance with local ordinances where applicable.

b. Non-hazardous

Non-hazardous waste should be removed immediately from those areas accessible to people. Since such wastes can provide breeding grounds for vermin they therefore present a health hazard. In addition, people, especially children, can injure themselves by coming into physical contact with the waste material.

Removal and disposal should be in accordance with applicable local ordinances.

Involvement (Community)

Intercepts: IV.(A,B,C,D).(1,2,3,4)-6

It would be very desirable to utilize "self-help" labor for the installation of rigid board products. With proper supervision, a minimal amount of training would be required, and considerable cost savings could be realized. In addition, the skills attained in such a program could provide the basis for better job opportunities for the workers involved.

Involvement (User)

Intercepts: IV.(A,B,C,D).(1,2,3,4)-7

Occupants should be removed from the room in which cover-up work is done to avoid exposing them to potential hazards.

Where cutting products to size generates a considerable amount of dust, the cutting operation should be located at a place which does

not expose the occupants to dust.

Degree of Finish

Intercepts: IV.(A,B,C,D).(1,2,3,4)-8

a. Gypsum board, plywood, and hardboard

Unfinished gypsum board, plywood, and hardboard were meant to be coated with a suitable surface finish (See Matrix VI, Surface Finish Methods for suitable surface treatments).

Without adequate protection the above board products are very prone to attack by water and other liquids with serious deterioration resulting.

b. Metal

Metal panels may be supplied in a primed, semi-finished state or with chipped, marred surfaces. For adequate in-use service, a suitable finish should be provided.

4. FUTURE WORK

Matrices II, III, V, and VI, indexed in Figure II, Decision Model Part 2 will be analyzed in a similar fashion to determine their relevance to deleading programs.

REFERENCES

[1]Personal Communication with Mr. Samuel Toner of Product Evaluation Division, National Bureau of Standards.

[2]Personal Communication with Mr. Gerald Brauer of the Dental Research Section, Polymers Division, National Bureau of Standards.

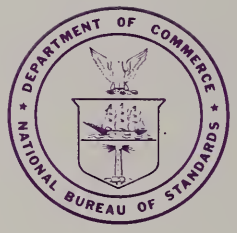
APPENDIX A

Indexing System for Hazard Elimination Matrices

An explanation of the indexing system used in the hazard elimination methods follows. The matrices are numbered with Roman Numerals from I thru VI. Going down the left column of a matrix each major category is assigned a capitol letter with sub classifications indicated by small letters. The place a method is being applied e.g., walls, is designated by the numbers 1 thru 4.

In going across the top row of each matrix the attributes of the method are numbered consecutively. Any sub classifications are indicated by small letters. A dash is used to separate the rows from the columns in an index number.

For example, with index number I.A.1-4, the I represents Removal Methods, A indicates Sanding, 1 stands for walls and 4 designates Ancillary Work.


DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS